ARAC WG Report Format

1 - What is underlying safety issue addressed by the FAR/JAR? **[Explain the underlying safety rationale for the requirement. Why does the requirement exist?]**

Ruptures of pneumatic and pressurization system elements (components and ducts) can lead to unsafe conditions due to system malfunction or loss and can cause ancillary damage to critical systems. The rules define design and test requirements for pneumatic and pressurization system elements to ensure reliable and safe operation

2 - What are the current FAR and JAR standards? **[Reproduce the FAR and JAR rules text as indicated below.]**

FAA REQUIREMENTS

cfr.14.25.1438
§ 25.1438 Pressurization and Pneumatic Systems.

Date: January 1, 1998

(a) Pressurization system elements must be burst pressure tested to 2.0 times, and proof pressure tested to 1.5 times, the maximum normal operating pressure.

(b) Pneumatic system elements must be burst pressure tested to 3.0 times, and proof pressure tested to 1.5 times, the maximum normal operating pressure.

(c) An analysis, or a combination of analysis and test, may be substituted for any test required by paragraph (a) or (b) of this section if the Administrator finds it equivalent to the required test.

[Amdt. 25-41, 42 FR 36971, July 18, 1977]

JAA REQUIREMENTS

jar.25.25.1438
JAR 25.1438 Pressurization and low pressure pneumatic systems

Date: May 27, 1994

Pneumatic systems (ducting and components) served by bleed air, such as engine bleed air, air conditioning, pressurization, engine starting and hot-air ice-protection system which are essential for the safe operation of the airplane or whose failure may affect any essential or critical part of the airplane or the safety of the occupants, must be so designed and installed as to comply the JAR 25.1309 In particular account must be taken of bursting or excessive
leakage. (See ACJ 25.1438 paragraph 1 for strength and ACJ 25.1438 paragraph 2 for testing.)

ar.25.s2.acj.25.1438
ACJ 25.1438 - Pressurization and Low Pressure Pneumatic Systems (Acceptable Means of Compliance)

Date: May 27, 1994

See JAR 25.1438

1 Strength

1.1 Compliance with JAR 25.1309(b) in relation to leakage in ducts and components will be achieved if it is shown that no hazardous effect will result from any single burst or excessive leakage.

1.2 Each element (ducting and components) of a system, the failure of which is likely to endanger the aeroplane or its occupants, should satisfy the most critical conditions of Table 1.

TABLE 1

Conditions 1	Conditions 2
1.5 P1 at T1	3.0 P1 at T1
1.33 P2 at T2	2.66 P2 at T2
1.0 P3 at T3	2.0 P3 at T3
--	1.0 P4 at T4

P1 = the most critical value of pressure encountered during normal functioning.

T1 = the combination of internal and external temperatures which can be encountered in association with pressure P1.

P2 = the most critical value of pressure corresponding to a probability of occurrence 'reasonably probable'.

T2 = the combination of internal and external temperatures which can be encountered in association with pressure P2.

P3 = the most critical value of pressure corresponding to a probability of occurrence 'remote'.

T3 = the combination of internal and external temperatures which can be encountered in association with pressure P3.

P4 = the most critical value of pressure corresponding to a probability of occurrence 'extremely remote'.

T4 = the combination of internal and external temperatures which can be encountered in association with pressure P4.

1.3 After being subjected to the conditions given in column 1 of Table 1, and on normal operating conditions being restored, the element should operate normally and there should be no detrimental permanent distortion.

1.4 The element should be capable of withstanding the conditions given in column 2 of Table 1 without bursting or excessive leakage. On normal operating conditions being restored, correct functioning of the element is not required.

1.5 The element should be capable of withstanding, simultaneously with the loads resulting from the temperatures and pressures given in the Table, the loads resulting from --

a. Any distortion between each element of the system and its supporting structures.

b. Environmental conditions such as vibration, acceleration and deformation.

1.6 The system should be designed to have sufficient strength to withstand the handling likely to occur in operation (including maintenance operations).

2 Tests

2.1 Static tests. Each element examined under 1.2 should be static-tested to show that it can withstand the most severe conditions derived from consideration of the temperatures and pressures given in the Table. In addition, when necessary, sub-systems should be tested to the most severe conditions of 1.2 and 1.5. The test facility should be as representative as possible of the aircraft installation in respect of these conditions.

2.2 Endurance tests. When failures can result in hazardous conditions, elements and/or sub-systems should be fatigue-tested under representative operating conditions that simulate complete flights to establish their lives.

jar.25.25x1436
JAR 25X1436 Pneumatic systems -- high pressure

Date: May 27, 1994

(a) General. Pneumatic systems which are powered by, and/or used for distributing or storing, air or nitrogen, must comply with the requirements of this paragraph.

(1) Compliance with JAR 25.1309 for pneumatic systems must be shown by functional tests, endurance tests and analysis. Any part of a pneumatic system which is an engine accessory must comply with the relevant requirements of JAR 25.1163.

(2) No element of the pneumatic system which would be liable to cause hazardous effects by exploding, if subject to a fire, may be mounted within an engine bay or other designated fire zone, or in the same compartment as a combustion heater.

(3) When the system is operating no hazardous blockage due to freezing must occur. If such blockage is liable to occur when the airplane is stationary on the ground, a pressure relieving device must be installed adjacent to each pressure source.

(b) Design. Each pneumatic system must be designed as follows:

(1) Each element of the pneumatic system must be designed to withstand the loads due to the working pressure, PW, in the case of elements other than pressure vessels or to the limit pressure, PL, in the case of pressure vessels, in combination with limit structural loads which may be imposed without deformation that would prevent it from performing its intended function, and to withstand without rupture, the working or limit pressure loads multiplied by a factor of 1.5 in combination with ultimate structural loads that can reasonably occur simultaneously.

(i) PW. The working pressure is the maximum steady pressure in service acting on the element including the tolerances and possible pressure variations in normal operating modes but excluding transient pressures.

(ii) PL. The limit pressure is the anticipated maximum pressure in service acting on a pressure vessel, including the tolerances and possible pressure variations in normal operating modes but excluding [transient pressures.]

(2) A means to indicate system pressure located at a flight-crew member station, must be provided for each pneumatic system that --

(i) Performs a function that is essential for continued safe flight and landing; or

(ii) In the event of pneumatic system malfunction, requires corrective action by the crew to ensure continued safe flight and landing.

(3) There must be means to ensure that system pressures, including transient pressures and pressures from gas volumetric changes in components which are likely to remain closed long enough for such changes to occur --

(i) Will be within 90 to 110% of pump average discharge pressure at each pump outlet or at the outlet of the pump transient pressure dampening device, if provided; and

(ii) Except as provided in sub-paragraph (b)(6) of this paragraph, will not exceed 125% of the design operating pressure, excluding pressure at the outlets specified in sub-paragraph (b)(3)(i) of this paragraph. Design operating pressure is the maximum steady operating pressure.

The means used must be effective in preventing. excessive pressures being generated during ground charging of the system. (See ACJ 25X1436 (b)(3).)

(4) Each pneumatic element must be installed and supported to prevent excessive vibration, abrasion, corrosion, and mechanical damage, and to withstand inertia loads.

(5) Means for providing flexibility must be used to connect points in a pneumatic line between which relative motion or differential vibration exists.

(6) Transient pressure in a part of the system may exceed the limit specified in sub-paragraph (b)(3)(ii) of this paragraph if --

(i) A survey of those transient pressures is conducted to determine their magnitude and frequency; and

(ii) Based on the survey, the fatigue strength of that part of the system is substantiated by analysis or tests, or both.

(7) The elements of the system must be able to withstand the loads due to the pressure given in Appendix K, for the proof condition without leakage or permanent distortion and for the ultimate condition without rupture. Temperature must be those corresponding to normal operating conditions. Where elements are constructed from materials other than aluminum alloy, tungstun or medium-strength steel, the Authority may prescribe or agree other factors.
The materials used should in all cases be resistant to deterioration arising from the environmental conditions of the installation, particularly the effects of vibration.(AMENDED BY ORANGE PAPER AMENDMENT 25/96/1)

(8) Where any part of the system is subject to fluctuating or repeated external or internal loads, adequate allowance must be made for fatigue.

(c) Tests

(1) A complete pneumatic system must be static tested to show that it can withstand a pressure of 1.5 times the working pressure without a deformation of any part of the system that would prevent it from performing

its intended function. Clearance between structural members and pneumatic system elements must be adequate and there must be no permanent detrimental deformation For the purpose of this test, the pressure relief valve may be made inoperable to permit application of the required pressure.

(2) The entire system or appropriate sub-systems must be tested in an airplane or in a mock-up installation to determine proper performance and proper
relation to other airplane systems. The functional tests must include simulation of pneumatic system failure conditions. The tests must account for flight loads, ground loads, and pneumatic system working, limit and transient pressures expected during normal operation, but need not account for vibration loads or for loads due to temperature effects. Endurance tests must simulate the repeated complete flights that could be expected to occur in service.
Elements which fail during the tests must be modified in order to have the design deficiency corrected and, where necessary, must be sufficiently retested.
Simulation of operating and environmental conditions must be completed on elements and appropriate portions of the pneumatic system to the extent necessary to evaluate the environmental effects. (See ACJ 25X1436 (c)(2).)

(3) Parts, the failure of which will significantly lower the airworthiness or safe handling of the airplane must be proved by suitable testing, taking into account the most critical combination of pressures and temperatures which are applicable.

jar.25.s2.acj.25x1436.b.3
ACJ 25X1436(b)(3) - Pneumatic Systems (Interpretative Material)

Date: May 27, 1994

See JAR 25X1436(b)(3)

1 In systems in which the air pressure of the supply sources is significantly greater than the system operating pressure (e.g. an engine bleed-air tapping) due account should be taken of the consequences of failure of the pressure-regulating device when assessing the strength of the system, downstream of the device relative to the values of PW, PL and PR.

2 Such devices should be protected as necessary against deleterious effects resulting from the presence of oil, water or other impurities which may exist in the system.

jar.25.s2.acj.25x1436.c.2
ACJ 25X1436(c)(2) - Pneumatic Systems (Interpretative Material)

Date: May 27, 1994

See JAR 25X1436(c)(2)

The loads due to vibration and the loads due to temperature effects are those loads which act upon the elements of the system due to environmental conditions.

The MSHWG has been using the JAA PNPA25F-293 Issue 1 Dated May 19, 1998 as the basis for harmonization since the PNPA had been released for comment and was ready to be published in JAR 25 change 15.

[Appendix K (No equivalent in FAR Part 25)]

Element of System	Strength Value		Remarks
	Proof	Ultimate	
Rigid pipes and ducts	1·5 Pw	3·0 Pw	
Couplings	1·5 Pw	3·0 Pw	
Flexible hoses	2 0 Pw	4·0 Pw	
Return line elements	—	1·5 Pr	Pr The maximum pressure applied during failure conditions.
Components other than pipes, couplings, ducts or pressure vessels	1·5 Pw	2·0 Pw	
Pressure vessels fabricated from metallic materials. (For non-metallic materials see JAR 25.1435(a)(10) and JAR 25X1436(b)(7))			
Pressure vessels connected to a line source of pressure	3·0 PL or 1·5 PL	4·0 PL or 2·0 PL	The lower values are conditional upon justification by a fatigue endurance test from which a permissible fatigue life is declared, and upon the ultimate load test being made on the test specimen used for the fatigue life test.
Pressure vessels not connected to a line source of pressure, e.g. emergency vessels inflated from a ground source	2·5 PL or 1·5 PL	3·0 PL or 2·0 PL	The lower values are conditional upon justification by a life endurance test of a suitably factored permissible number of inflation/deflation cycles, including temperature fluctuation results in a significant pressure variation, and upon the ultimate load test being made on the test specimen used for the life endurance test. For all pressure vessels: (1) The minimum acceptable conditions for storage, handling and inspection are to be defined in the appropriate manual. See JAR 25.1529(h). (2) The proof factor is to be sustained for at least three minutes. (3) The ultimate factor is to be sustained for at least one minute. The factor having been achieved, the pressure vessel may be isolated from the pressure source for the remaining portion of the test period.

3 - What are the differences in the standards and what do these differences result in?:
[Explain the differences in the standards, and what these differences result in relative to (as applicable) design features/capability, safety margins, cost, stringency, etc.]
See Table A

TABLE A

ITEM	Description	FAR 25.1438	JAR 25X1436 NPA 25F-293	JAR 25.1438	Report Question 3 Response (Relevance of Difference)	Report Question 4 Respons (Compliance Criteria)
1	General rule structure	Rule description are within 25.1438	Rule description is within the JAR	Rule refers to ACJ which contains all details	Differences in rule structure can lead to compliance confusion and additional certification constraints	FARs and JARs are requirements. The ACJ to JAR 25.1438 is an acceptable means of compliance.
2	Probability of occurrence. Normal operation and multiple failures	Probability is not addressed System failures not considered	Probability is not addressed	ACJ assigns a pressure multiplier for each specific probability of occurrence. 1) 1.5x & 3.0x @ "normal functioning" 2) 1.33x & 2.66x@"reasonably probable" 3) 1x & 2x @ "remote" 4) none & 1x @ "extremely remote"	The JAR requirements account for failure conditions which can require higher design factors.	JAR requires more analysis and test a is more stringent. JAR25.148 requires probability analysis to determine prope design factors.
3	Multiplier for various systems	Pressurization 1.5x & 2x Pneumatic- 1.5x & 3x Air-conditioning -- none Engine Starting - none Ice Protection -- none	Compliance level does not vary with different systems.	Compliance level does not vary with different systems. System listed are air conditioning , Pressurization, engine starting, & I/P	The JAR25.1438 requires higher factors for pressurization systems and may result in additional test and analysis. The JAR25X1436 requires higher factors for specific system components (pressure vessels, hoses)	JARs result in more analysis and testing .
4	System function after "condition 1" proof	Does not address system requirement after a Proof event.	Elements should withstand proof without permanent deformation and negative effects on intended function	Element should operate normally and with no detrimental permanent distortion.	JAR sets acceptance requirements more clearly and provides a more standardized acceptance criteria.	JAR defines post test acceptance criteria
5	System function after "condition 2" burst	Does not address system requirement after a burst event.	Elements should withstand burst without rupture	Element should withstand burst pressure without bursting or excessive leakage	JAR sets acceptance requirements more clearly and provides a more standardized acceptance criteria.	JAR defines post test acceptance criteria

6	Combined load requirements	None	Must consider additional loads: structural and externally induced loads	Must consider additional load: 1)"loads resulting from any distortion between each element of the system and its supporting structures". 2) Vibration, acceleration and deformation.	The JAR includes combined loads for pressurization and pneumatic systems and may result in additional test and analysis.	JAR requires consideration of combined loads requiring additional analysis and improved tests.
7	Testing	No mention of testing	Tests addressed in requirement	Section 2 of ACJ address testing: 2.1 Static tests, and 2.2 Endurance tests.	JAR test requirements are more expensive and time consuming.	JAR requires more complicated testing including a complete system.

The JAA applies JAR Paragraph 25X1436 to pneumatic systems not covered by 25.1438 such as slide deployment systems, thrust reverser actuation systems, door release mechanisms. There is no equivalent FAR 1436. The FAA applies FAR 1301, 1309, 25.1438 to pneumatic systems and Department Of Transportation (DOT) regulations to gas storage devices. The JAR also distinguishes between pneumatic systems and high pressure systems. Part 25.1438 of the FAR and Paragraph 25X1436 of the JAR have been applied to gas storage devices such a hydraulic accumulators. JAR 25X1436 applies to the installation including the piping and components of high-pressure systems. No equivalent FAA rule leads to inconsistent compliance means, which may not support JAA certification requirements resulting in additional certification documentation and testing.

4 - What, if any, are the differences in the means of compliance? **[Provide a brief explanation of any differences in the compliance criteria or methodology, including any differences in either criteria, methodology, or application that result in a difference in stringency between the standards.]**
See Table A

5 – What is the proposed action? **[Is the proposed action to harmonize on one of the two standards, a mixture of the two standards, propose a new standard, or to take some other action? Explain what action is** being proposed (not the regulatory text, but the underlying rationale) and why that direction was chosen.]

The proposed action is to merge the requirements of all the rules, to compare these requirements with industry standards and to simplify the rule by using the industry standards which have resulted in systems that have been demonstrated safe by service experience. The harmonized 1438 rule will combine the requirements of FAR 1438, JAR 1438 and 1436 into one harmonized rule and eliminate the need for JAR 1436 and the ACJ 1438. This method was chosen after an investigation of rule contents and applications of JAR25X1436 in state-of-the-art-design. As the NPA25F-293 to JAR25X1436 is mature for publication in the JAA-system the group agreed to take it as basis for inclusion. JAA accepted this proceeding. Without inclusion of JAR25X1436 it would be necessary to create a corresponding FAR25.1436 to achieve harmonization within the scope of the MSHWG. The so harmonized and simplified rule is in line with industry standards which have resulted in systems that have been demonstrated safe by A/C certifications and service experience.

6 - What should the harmonized standard be? **[Insert the proposed text of the harmonized standard here]**

. 25.1438 Pneumatic Systems

(a) This requirement is applicable to pneumatic systems and elements (components and ducting) served by gas storage devices such as, evacuation, water systems, accumulators and/or pressurized gas from compressors such as engine and APU bleed air, air conditioning, pressurization, engine starting, ice-protection, and pneumatic actuation systems. Design compliance may be in the form of analysis, test, or combination of analysis and test. All foreseen normal and failure mode combinations of environmental loads (installation, thermal, vibration, and aerodynamic), pressures, temperatures, material properties, and dimensional tolerances must be considered. This requirement is not applicable to portable gas storage devices.

(b) Each element of the system must be designed to operate without detrimental permanent deformation or increase in design leakage that would prevent the element from performing its intended function. For demonstrating compliance, the following factors are to be applied to the pressure at the associated temperature for the most critical of the following conditions:

- 1.5 times maximum normal operating
- 1.33 times the failure pressure occurring in the probability range between 10E-03 to 10E-05 failures/flight hour
- 1.0 times the failure pressure occurring in the probability range between 10E-05 to 10E-07 failures/flight hour
- 1.0 times the maximum normal operating pressure in combination with the limit structural loads

After being subjected to the above conditions and on normal operating conditions being restored, the element should operate normally.

(c) Each element of the system must be designed to operate without rupture or increase in design leakage which is likely to endanger the airplane or its occupants. For demonstrating compliance, the following factors are to be applied to the pressure at the associated temperature for the most critical of the following conditions:

- 3.0 times maximum normal operating pressure. Pressurization system elements shall use a factor of 2.0 time maximum normal operating pressure
- 2.66 times the failure pressure occurring in the probability range between 10E-03 to 10E-05 failures/flight hour
- 1.5 times the failure pressure occurring in the probability range between 10E-05 to 10E-07 failures/flight hour is applicable to components. Ducting shall use a factor of 2.0 times the failure pressure occurring in the probability range between 10E-05 to 10E-07 failures/flight hour

- 1.0 times the failure pressure occurring in the probability range between 10E-07 to 10E-09 failures/flight hour
- 1.5 times the maximum normal operating pressure in combination with the 1.0 times the ultimate structural loads

After being subjected to the above conditions and on normal operating conditions being restored, the element need not operate normally.

(d) If the failure of an element can result in a hazardous condition, it must be designed to withstand the fatigue effects of all cyclic pressures, including transients, and associated externally induced loads and perform as intended for the design life of the element under all environmental conditions for which the airplane is certified.

(e) In addition, each gas storage device must meet the requirement of this rule and not cause hazardous effects by exploding when installed. Other standards may be made applicable by the local authority.

7 - How does this proposed standard address the underlying safety issue (identified under #1)? **[Explain how the proposed standard ensures that the underlying safety issue is taken care of.]**

The new ruling clearly defines design and compliance criteria in one rule without relying on separate documents and defines minimum design and test standards for pneumatic and pressurization system components and pressure vessels. The harmonized rule merges existing proven requirements and industry standards which have resulted in safe aircraft systems with proven service experience

8 - Relative to the current FAR, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. **[Explain how each element of the proposed change to the standards affects the level of safety relative to the current FAR. It is possible that some portions of the** proposal may reduce the level of safety even though the proposal as a whole may increase the level of safety.]

The proposed standard formally improves the level of safety, ensures competitiveness and state-of-the-art levels of safety and reliability of aircraft pneumatic systems. It supplements the FAR standard with design and test requirements used by major manufacturers, government organizations and industry which have been validated by service experience. This has enabled the industry also to meet the corresponding JARs which include aspects of these industry practices or have formalized them in advisory material.

The industry practices (consideration of fatigue strength and system failure conditions, increased margins of safety for failure pressures related to their probabilities of occurrence, gas storage devices etc.) have been incorporated into the proposed standard and its regulatory content is significantly improved because important safety relevant practices are now set as a minimum standard, and thus, enforceable.

For failure conditions, new pressure factors have been introduced into the proposed rule. The proposed rule requires applicants to design and test the bleed air system considering installation and operating loads. The existing rule only required static pressure tests based on a normal operating pressure multiplied by a factor. The existing rule did not account for factors introduced on bleed air systems from installation and operating conditions.

9 - Relative to current industry practice, does the proposed standard increase, decrease, or maintain the same level of safety? Explain. **[Since industry practice may be different than what is required by the FAR (e.g., general industry practice may be more restrictive), explain how each element of** the proposed change to the standards affects the level of safety relative to current industry practice. Explain whether current industry practice is in compliance with the proposed standard.]

The proposed standard maintains the same level of safety relative to current industry practice, which is in compliance with the proposed standard. It is derived in part from the requirements used to design and qualify transport aircraft systems and components of major United States and European manufacturers which have demonstrated their products safe operation in service. Design factors for components having relatively low reliability may be higher than used by Boeing in the past, however data show that the design factors which have been used are consistent with the components' higher reliability and are in line with the proposed rule.

10 - What other options have been considered and why were they not selected?: **[Explain what other options were considered, and why they were not selected (e.g., cost/benefit, unacceptable decrease in the level of safety, lack of consensus, etc.]**

The most stringent requirements of the FAR and JAR were considered to be incorporated into one ruling. Analysis and service experience was used to show that a level of requirements lower than JAR 25.1438/ACJ25.1438, but combined with standards like the BOEING Design Requirements and Objectives (DRO) or the American Department of Transport standards, have proven satisfactory at reduced cost and weight to the industry. Several Type Certificate (TC) applicants have applied for an exception to JAR 25.1438 airplanes. The exception has been approved by the Joint Aviation Authorities based on the presentation of procedures and standards used to supplement FAR25.1438 (Equivalent safety finding). The exception allowed the TC applicant to show compliance to JAR 25.1438 by using in service experience of pneumatic duct components that were tested to factors lower than specified in JAR 25.1438.
Also, a new FAR 25.1436 was considered, the same as the JAR25X1436. Based on investigations of content and applications for JAR25X1436 it was decided to combine the requirements of JAR25X1436 into a single merged rule (named JAR/FAR25.1438) to eliminate confusion and competing requirements for like systems.

11 - Who would be affected by the proposed change? **[Identify the parties that would be materially affected by the rule change – airplane manufacturers, airplane operators, etc.]**

Airplane manufactures and suppliers will benefit from the single well defined harmonized ruling reducing certification costs. Manufactures and suppliers not in the global market, may have increased costs. Amongst others the proposed rule added fatigue design requirements and pressure factors for certain failure modes. The proposed rule may increase costs for TC applicants manufacturers that have only showed compliance to §25.1438 and for those applicants that do not have experience in fatigue design requirements and probability analysis tools/skills.

12 - To ensure harmonization, what current advisory material (e.g., ACJ, AMJ, AC, policy letters) needs to be included in the rule text or preamble? **[Does the existing advisory material include substantive requirements that should be contained in the regulation? This may occur** because the regulation itself is vague, or if the advisory material is interpreted as providing the only acceptable means of compliance.]

No current advisory material should be included, however the preamble should include the following-

PREAMBLE

SUMMARY: This notice proposes to revise the requirements for pneumatic and pressurization systems by specifying load factors in combination with proof and burst pressure factors in the rule. This action is in response to the Aviation Rulemaking Advisory Committee (ARAC) Mechanical Systems Harmonization Working Group recommendation to harmonize paragraphs 25X1436 and 25.1438 of the Joint Aviation Requirements (JAR) with part 25.1438 of the Federal Aviation Regulations (FAR).

BACKGROUND

On September 2, 1998 the FAA issued a Notice of a new task to harmonize §25.1438 with JAR Paragraphs 25X1436 and 25.1438. The notice was issued to inform the public that the FAA has asked ARAC to provide advice and recommendations on harmonization of the FAA regulations and JAA requirements for pressurization and pneumatic systems. This Notice of Proposed Rulemaking proposes a new Pneumatic and Pressurization rule that has been harmonized to satisfy both the FAA and JAA.

General Discussion:

The intent of this rule is to combine the requirements of section 25.1438 of the Federal Aviation Regulations (FAR), paragraph 25X1436 and 25.1438 Joint Aviation Requirements (JAR), and the advisory material for paragraphs 25X1436 and 25.1438 of the JAR into one rule. The rule format is similar to the advisory material for JAR 25.1438, however, the design standards have been placed in the text of the rule instead of the advisory material.

The multipliers from JAR25X1438 and those from the advisory material for JAR25.1438 have been adapted based on airplane manufacturer design practice and service history. This rule applies to bleed air and gas storage served systems like air conditioning, pressurization emergency deployment system and their elements.
For the purpose of this rule-
-the bleed air and air conditioning system elements include the ducting, control devices and components from the air supply source to the pressure bulkhead.
-Pressurization system elements are the elements exposed to cabin pressure. Pressurization system elements include the out flow valve and pressure relief valves. This rule does not apply to the structural parts of the pressurized cabin.
- An element is considered to be any component, tube or duct in the pneumatic or pressurization system.

This rule has been changed to harmonize and clarify sections 25.1438 of the FAR and JAR 25.1438. Current versions of §25.1438 of the FAR and paragraph 25.1438 of the JAR do not require the applicant to demonstrate compliance to the rules using the worst possible combination of temperature and pressure. In addition, §25.1438 of the FAR does not require the applicant to consider stress loads on pneumatic system components from pressure & temperature changes in combination with vibration and external loads. The proposed changes in the rule reflect current airplane manufacturer design practices.

Section 25.1438 of FAR and the advisory material for paragraphs 25X1436 and 25.1438 of the JAR require different proof and burst pressure multipliers for high pressure pneumatic systems, pressurization and pneumatic systems normal and abnormal conditions. The JAR also distinguishes between high and low pressure pneumatic systems. Part 25.1438 of the FAR and paragraph 25X1436 of the JAR have been applied to gas storage devices such a hydraulic accumulators. The MSHWG was tasked by the FAA to consider JAR 25X1436 in the harmonization rule because JAR 25X1436 and § 25.1438 both apply to gas storage devices such as hydraulic accumulators.

JAR 25X1436 has been applied to gas storage devices such as hydraulic system accumulators used in back up thrust reverser, flight control, and nitrogen bottles used in door opening and evacuation systems. The FAA applies Department of Transportation (DOT) regulations to gas storage devices such as nitrogen and oxygen bottles. The MSHWG found it acceptable to include requirements for gas storage devices in the rule; however, each country can apply national standards in addition to the proposed minimum requirement for gas storage devices.

JAR 25X1436 applies to the installation including the piping and components of high-pressure systems. The MSHWG has determined the requirements the harmonized rule for pneumatic and pressurization system rule will accommodate installation of the system, this includes the piping and components of pneumatic systems, including gas storage devices. As a result the intent of 25X1436 will be captured within the

harmonized rule for 25.1438, therefore eliminating the need for a separate rule. Pressure requirements specified in the harmonized rule apply to the system and components including actuators, pressure control regulators, pressurized lines to the regulating devices, and pressure sensors. Piping and components of gas storage devices covered by DOT regulations must meet the new requirements specified in this rule.

Section 25.1438 of the FAR has been applied by the JAA to oxygen systems down stream of the regulating device. The FAA now also will apply this rule to oxygen systems down stream of the first regulating device until the rules governing oxygen systems supercede this requirement.

Section 25.1438 of the FAR and the advisory material for JAR 25.1438 currently list different proof and burst pressure multipliers for pneumatic and pressurization systems. Application of the multipliers has not been consistent from one airplane program to the next program because the rules do not clearly distinguish where the pneumatic system ends and the pressurization system starts. This rule eliminates the need to define pneumatic systems and pressure systems because ducting and components must be designed to withstand the pressures of upstream component failures based on the probability of the upstream component failure. Distribution duct failures located in the pressurized cabin do not have to show compliance with this rule (unless the failure is hazardous to the airplane or occupants) because the failure does not cause the cabin to depressurize.

Section 25.1438 of the FAR currently require a set of multipliers for proof and burst pressure testing for both the pneumatic and pressurization systems based on normal operating pressure. The basis of the multipliers in the FAR is not currently known. It is believed the multipliers in §25.1438 were based on military or industry specifications. The advisory material for JAR 25.1438 uses pressures and related temperatures derived from probability of component failures to determine burst and proof pressure multipliers. Members of the MSHWG agree that a proof and burst test requirement does not necessarily represent the highest stress conditions encountered during operation. The MSHWG decided to develop the multipliers in the harmonized rule to reflect industry practices used to design pressurized ducting in airplane systems. In showing compliance to this rule the normal operating pressure is multiplied by the factor specified in the proposed rule in combination with highest stress condition resulting from the realistic simultaneous application of pressure/temperature combined with duct, vibration, and external loads. The normal operating pressure is the maximum pressure the system uses in normal operations during the flight envelope. The flight envelope includes take off and landing.

Section 25.1438 of the FAR and JAR 25.1438 do not require consideration of weaker material strength in the design as the system ages. If the material strength decreases due to aging, then the applicant must account for the aged material condition in showing design compliance to the requirements in this rule.

The value of each multiplier is based on airplane manufacture design practices. The airplane manufacturer data showed these design practices resulted in a long reliable service history for bleed air systems and components.

Maximum normal operating pressure is the highest value of pressure occurring at any time during steady state normal operating conditions, with all the components of the system functioning normally. Higher pressures occurring momentarily, such as during normal operating transients must be accounted for when considering failure conditions. .

References to FAR 25.1309 which is in the present JAR 25.1438 were not included in this rule. Section 25.1309 of the FAR applies to all airplane systems regardless of special references in this rule or any other rule.

Proposed Rule Discussion:

Paragraph (a) of the proposed rule is written to define the applicable systems that the rule applies too and list the conditions that must be considered in combination with the proof and burst pressure test requirements in paragraphs (b) and (c). The intent of this rule is to require the conditions in paragraph (a) to be combined with the specified test requirements in paragraphs (b) and (c) when showing compliance to this rule.

Paragraph (b) defines the first test condition and the pass/fail criteria. The element must be shown to operate without detrimental permanent deformation or increase in design leakage that would prevent the element from performing its intended function after the element is tested to the conditions specified in paragraph (b). The „most critical condition" is the worst combination of the factors specified in paragraph (a). Compliance must be show by testing the element to the factors specified in paragraph (b) in combination with the "most critical condition". Analysis may be used to show compliance with this rule provided the analysis is validated by test results using similar systems or components. Engine over speed conditions resulting in higher than normal operating pressures are considered as a first failure when showing compliance to this condition.

Paragraph (c) defines the second test condition and the pass/fail criteria for that condition. Like paragraph (a) the „most critical condition" is the worst combination of the factors specified in paragraph (a). Compliance must be show by testing the element to the factors specified in paragraph (c) in combination with the „most critical condition". Analysis may be used to show compliance with this rule provided the analysis is demonstrated reliable based on test results from similar systems or components. The test element need not operate normally after being subjected to the conditions in paragraph (c). Engine over speed conditions considered resulting in higher than normal operating pressures are considered as a first failure when showing compliance to this condition.

Paragraph (d) defines design criteria for components that can be hazardous to the airplane or the occupants. Hazardous to the airplane or occupants is defined in accordance with JAR/FAR25.1309 as any effect

-that could cause serious injury to or death of a relatively small portions of the occupants,
-that largely reduces the margins of safety
-that results in physical distress or a workload such that the flight crew cannot be relied upon to perform their tasks accurately or competely

Paragraph (e) defines requirements for gas storage devices.

DEFINITION OF TERMS

Air Conditioning System
All elements comprising the system which control the airflow, gas composition and temperature to the pressurized zones of the airplane
Components
All elements of the pneumatic system, which perform mechanical, pneumatic, thermodynamic, electric functions or are used in controlling these functions
Compressor
Any machine which increases gas pressure

Design Life
The time that the component will perform its intended function, including overhauls before it is permanently replaced
Design Leakage
The value of airflow exiting a component, either internally or externally for which the system and surrounding systems have been designed to accommodate
Detrimental Deformation
A change of physical shape which reduces the structural integrity or the design fatigue life of the element or reduces normal operating system performance
Ducts
All elements of the system, having no moving parts, which direct and transport gas from one component of the system to another.
Elements
All individual components (for example ducts, valves, tubes, couplings, brackets, controllers, sensors etc) comprising the system.
Exploding
Pneumatic rupture of an element resulting in a sudden and violent release of energy
Failure Mode
Set of conditions which result in an element not performing as intended
Failure Pressure or Temperature
The value of pressure or temperature which occurs at a point in a system as the result of a failure of a control device
Gas Storage Device
A component which acts as a resevoir for compressed gas, and which is designed to release the gas to serve user systems.
Hazardous Effects

A hazardous condition resulting from the failure of an airplane system or system element

Hazardous Condition

A failure of an element which endangers the airplane or its occupants

Maximum Normal Operating Pressure or Temperature

The highest pressure or temperature at a point in the system which occurs with all the elements of the system operating normally under steady state and transient conditions.

Most Critical

The combination of pressure and temperature imposed on an element which is being analyzed, that results in the smallest difference of actual stress and allowable stress.

Normal Mode

With all the component parts of the system operating normally

Pneumatic System

All of the elements of the system that convey gas and/or control pressure and temperature from compressed gas sources to provide a conditioned gas mass flow or provide energy to perform mechanical work.

Pressurization System

All elements comprising the system which control the air pressure of the airplane ~~occupied~~ pressurized zones

Tubing

Small diameter pipes, serving the same purpose as ducts, providing low airflow within or between components

13 - Is existing FAA advisory material adequate? If not, what advisory material should be adopted? **[Indicate whether the existing advisory material (if any) is adequate. If the current advisory material is not adequate, indicate whether the existing material should be revised, or new material provided.** Also, either insert the text of the proposed advisory material here, or summarize the information it will contain, and indicate what form it will be in (e.g., Advisory Circular, policy, Order, etc.)]

[]

No FAA advisory material exists nor is intended for the harmonized ruling. No ACJ 1438 will be required either. The harmonized ruling and preamble will be written to stand alone.

14 - How does the proposed standard compare to the current ICAO standard? **[Indicate whether the proposed standard complies with or does not comply with the applicable ICAO standards (if any)]**

"Due to their commitments as ICAO members the US and all JAA-countries converted ICAO requirements into their airworthiness codes. So both the JAR and FAR 25 at least fulfill the ICAO minimum standards. As the proposed standard does not decrease the level of safety of FAR or JAR25, it is in line with ICAO Annex 8 "Airworthiness of Aircraft"."

15 - Does the proposed standard affect other HWG's? **[Indicate whether the proposed standard should be reviewed by other harmonization working groups and why.]**

No.

16 - What is the cost impact of complying with the proposed standard? **[Is the overall cost impact likely to be significant, and will the costs be higher or lower? Include any cost savings that would** result from complying with one harmonized rule instead of the two existing standards. Explain what items affect the cost of complying with the proposed standard relative to the cost of complying with the current standard.]

The proposed new standard will reduce the overall cost and time of the joint certification process and will not increase cost for any present major manufacturer that has a service demonstrated safety record. An increase in certification costs may result to those manufactures applying only for FAA type certificate due to the addition of failure mode pressure factors and fatigue design requirements. In addition, certification of pressurized bottles may experience higher costs in analyzing pressure vessel rupture effects to ancillary systems. None of these costs are considered significant relative to the costs of potential warranty claims and product improvements

17 - Does the HWG want to review the draft NPRM at "Phase 4" prior to publication in the Federal Register?

YES

18 – In light of the information provided in this report, does the HWG consider that the "Fast Track" process is appropriate for this rulemaking project, or is the project too complex or controversial for the Fast Track Process. Explain. **[A negative answer to this question will prompt the FAA to pull the project out of the Fast Track process and forward the issues to the** FAA's Rulemaking Management Council for consideration as a "significant" project.]

The "Fast Track" process IS appropriate